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J. SLEPIAN

HOT CATHODE TUBE

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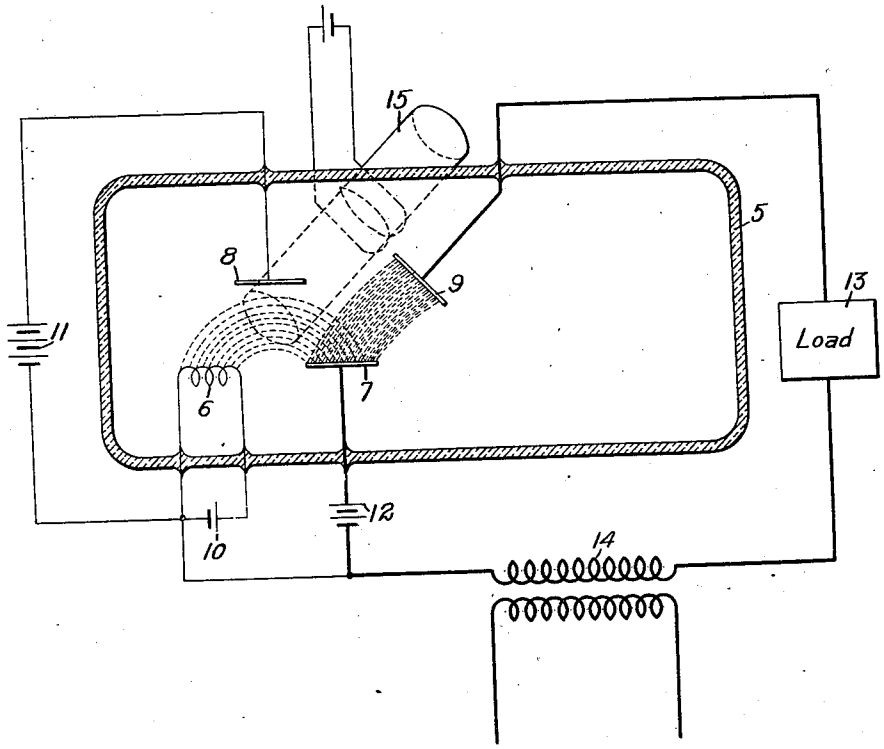

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UNITED STATES PATENT OFFICE.

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HOT-CATHODE TUBE.

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To all whom it may concern:

Be it known that I, JOSEPH SLEPIAN, a citizen of the United States, and a resident of Wilkinsburg, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Hot-Cathode Tubes, of which the following is a specification.

My invention relates to hot-cathode apparatus, such as is used for rectification and in detector-bulb work and it has for its object to provide apparatus of the character designated that shall embody means for providing a strong and effective electron emission.

The single figure of the accompanying drawing is a diagrammatic view of an electron tube, together with associated supply and auxiliary circuits, illustrating one application of my invention.

In the construction and operation of electron tubes, it has been usual to employ incandescent filaments as electron sources, these filaments being maintained at incandescence by the passage of heating current therethrough. The use of a filament of sufficient size and temperature to produce the large electron streams required in certain forms of apparatus engenders a relatively large amount of heat that must be dissipated and, furthermore, the filament is subject to rapid deterioration because of the high temperature at which it must be run, thus limiting the useful life of the apparatus.

I find that a relatively small incandescing filament may be operated at moderate temperatures to produce a small number of electrons and these electrons may be caused to make impact upon an adjacent electrode with high velocity by subjecting them to the influence of a high-voltage electrostatic field. As a result, there is produced a profuse emission of electrons from the adjacent electrode by the joint action of reflection and of secondary emission, it being well known that the impact of a high-velocity electron upon another body may set free a large number of low-velocity electrons therefrom.

The adjacent electrode, which is thus caused to be the seat of a profuse electron emission, may now be employed as a cathode in an auxiliary circuit, and a relatively large amount of current may be offered passage because of the large number of electrons available.

If desired, the above process may be repeated, and the electrons set free from the adjacent electrode be caused to make impact upon still another electrode, setting free a still larger number of electrons therefrom, and this process may be continued indefinitely.

A convenient method of manipulating the electron streams, in apparatus of this type, is by means of magnetic fields.

Referring to the drawing for a more detailed understanding of my invention, I show a tube at 5 which may either be highly exhausted or filled to a greater or less degree with a gas, such as argon, which offers an elastic impact, as is well known in the art. The tube 5 is provided with a filamentary electrode 6 and with a plate electrode 7 substantially in line therewith.

A plate electrode 8 is disposed opposite the electrodes 6 and 7, and a plate electrode 9 is disposed in angular position at the side of the electrode 7.

Heating current for the filament 6 is provided from a source 10, and the electrode 8 is maintained positive with respect to the electrode 6 by current from a source 11. The electrode 7 is maintained positive with respect to the electrode 6 by current from a source 12 and a unidirectional load-current device 13 is connected in circuit with the electrodes 7 and 9 through an alternating-current source 14.

A magnet 15 is disposed with one of its poles adjacent to the electrodes 6, 7 and 8, as shown.

Having thus described a combination of devices embodying my invention, the operation thereof is as follows. At the outset, the filament 6 is raised to incandescence and a relatively small number of electrons caused to be emitted therefrom. These electrons are drawn toward the electrode 8 and a relatively high velocity is imparted thereto by current from the source 11. Before reaching the plate, however, the electrons are directed into a cycloidal path, by the action of the magnet 15, to impinge upon the electrode 7 at an extremely high velocity. A certain number of the electrons, upon reaching the electrode 7, return to the cathode 6 through the current source 12, although, at the mo-

ment of impact, they set free a relatively large number of low-velocity electrons at the surface of the plate 7.

Certain other electrons, upon reaching the plate 7, set free other electrons and are then reflected so as to hit the plate 9. The plate 7 is thus caused to be a seat of profuse low-velocity electron emission and operates as a cathode in the circuit including the electrodes 7 and 9, the load 13 and the alternating-current source 14.

Thus, a relatively large electron stream may be maintained between the electrodes 7 and 9, for the rectification of large currents, with the operation of but a small filament 6, this filament being operative at moderate temperatures so as to be long-lived.

As previously set forth, this action may be repeated to any desired degree, the large electron emission from the electrode 7 being suitably directed, if desired, so as to make impact upon another electrode, a high velocity being imparted thereto by a suitable impelling electromotive force, and a suitable magnet or other means being employed for directing the electron stream.

While I have illustrated my invention for use in a rectifier, it is obvious that it may be employed to equal advantage in any other form of electron tube where profuse emission is desired, as in detector and amplifier work.

While I have shown my invention in its preferred form, it is susceptible of still other modifications and changes without departing from the spirit thereof and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or are specifically set forth in the appended claims.

I claim as my invention:

1. In a rectifying device, the combination with means for producing an electron stream, of a circuit including two spaced electrodes, an alternating-current source and a load, and means for deflecting said electron stream upon one of said electrodes whereby it functions as a cathode by secondary emission and by reflection and permits the rectification of current from said source.

2. In a rectifying device, the combination with means for producing an electron stream, of a circuit including two spaced electrodes, an alternating-current source and a load, and a magnet for deflecting said electron stream upon one of said electrodes whereby it functions as a cathode by secondary emission and by reflection and permits the rectification of current from said source.

3. The method of initiating rectification in a circuit including two spaced electrodes, an alternating-current source and a load, which comprises bombarding only one of said electrodes with an electron stream in such manner as to cause an electron emission to be initiated thereat by reflection and by secondary emission.

4. The method of initiating rectification in a relatively low-voltage circuit including a pair of spaced electrodes, an alternating-current source and a load which comprises bombarding only one of said electrodes with a stream of relatively few, high-velocity electrons and producing therefrom an emission of a relatively large number of low-velocity electrons by reflection and secondary emission.

5. In an electron tube, the combination with means for producing an electron stream embodying relatively few high-velocity electrons, of an electrode in the path of said stream, whereby a relatively large number of electrons are produced by reflection and secondary emission, and means including an anode and an electric circuit for utilizing said last-mentioned electron stream, said means being located substantially out of the path of said first-mentioned stream.

6. In an electron tube, the combination with an incandescing cathode, of means comprising an electrostatic field for directing and imparting high velocity to the electrons emitted therefrom, an electrode disposed in the path of said stream, whereby certain electrons are reflected and others are produced by impact, and means including an anode and an electric circuit for utilizing the resultant profuse electron emission, said means being substantially unaffected by said first-mentioned electron stream.

7. In apparatus for producing secondary electron emission, the combination with means for producing a primary electron emission, of a solid body disposed adjacent thereto, and magnetic means for deflecting said primary emission upon said solid body in such manner as to produce a secondary electron emission in a direction suitable for carrying said secondary emission out of the path of said primary emission.

8. In apparatus for producing secondary electron emission, the combination with means for producing a primary electron emission, of means for imparting high velocity to said primary emission, a solid body disposed adjacent thereto, and magnetic means for deflecting said primary emission upon said solid body in such manner as to produce a secondary electron emission in a direction suitable for carrying said secondary emission out of the path of said primary emission.

9. In apparatus for producing a profuse electron emission, the combination with means for producing a relatively small electron emission, of electrostatic means for imparting high velocity thereto, a solid body, and magnetic means for deflecting said small electron emission upon said solid body in such manner as to produce a secondary elec-

tron emission in a direction suitable for carrying said secondary emission out of the path of said primary emission.

10. In apparatus for producing secondary electron emission, the combination with means for producing a primary electron emission, of a plate disposed in such manner as to receive said primary electron emission at an acute angle to the surface thereof, said plate being adapted to emit secondary electrons, a second plate disposed so as to selectively receive the electrons emitted by said first-mentioned plate, and an electric circuit associated with said second plate.

11. In apparatus for producing secondary electron emission, the combination of means for producing a primary electron emission, of an electrode for producing a secondary electron emission upon being bombarded with said primary electron emission, said electrode being so disposed that the paths of said primary electron emission and said secondary electron emission are substantially different, and means including an electric circuit for utilizing said secondary electron emission.

12. A rectifying device comprising an electrode, means for producing an unobstructed flow of primary electrons impinging upon said electrode whereby a secondary electron stream is produced, and means including an anode and an electric circuit for utilizing said last mentioned electron stream.

13. A rectifying device comprising an electrode, means for producing an unobstructed flow of primary electrons impinging upon said electrode whereby a secondary electron stream is produced, and an electric circuit including an auxiliary electrode so placed as to receive an unobstructed stream of said secondary electrons.

14. A rectifying tube including a cathode adapted to emit primary electrons, an anode disposed in the path of said electrons, a second anode adapted to receive the secondary electrons produced by the impinging of the primary electrons upon said first mentioned anode, and a control electrode for said primary electrons, said control electrode being located out of the path of the stream of said primary electrons.

15. A rectifying tube including a cathode adapted to emit primary electrons, an anode disposed in the path of said electrons, a second anode adapted to receive the secondary electrons produced by the impinging of the primary electrons upon said first mentioned anode, a control electrode for said primary electrons, and magnetic means for causing said primary electrons to impinge upon said first mentioned anode against the action of the electric field of said control electrode.

In testimony whereof, I have hereunto subscribed by name this 2nd day of April, 1919.

JOSEPH SLEPIAN.